Nigerian Veterinary Journal Vol. 24 (2) 41-47

FISH LOSSES DUE TO BACTERIAL FLORA AND INFECTIONS OF FISHES IN KAINJI LAKE AREA, NIGERIA: A REVIEW

OMOJOWO*, F.S., AND SOGBESAN, O.A.

National Institute for Freshwater Fisheries Research,
P.M.B. 6006, New Bussa,Niger State, Nigeria.

* Correspondence

SUMMARY

This paper assesses the losses incurred as a result of bacterial flora and infection in captured and cultured fish. The role played by these bacterial flora on the overall quality and health of fish is discussed. Bacteria have been reported to cause diseases in ponds and increase in the spoilage rate of raw and preserved fish in fishing industry. Economically, spoilage in either capture or culture fisheries do result into reduction in the market price of fish leading to an economic loss in the fish industry venture. Proper recommendations were made to alleviate this and promote economically sustainable fisheries in Nigeria as government thinks of privatising her farms.

KEY WORDS: Bacterial flora, fish quality, spoilage, and economic loss.

INTRODUCTION

Nigeria with a projected population of 108.96 million in 2002 and has a projected fish demand of 2.1 million tonnes at 11.5kg per capital consumption (FAO, 2000). About 41% of this demand can be met by domestic production leaving a supply gap of 59%. Hence there is a need to improve fish production by more efficient fisheries management and the development of aquaculture and improvement in fish handling, processing, storage and distribution (Eyo, 1997) in order to close the gap of 59% deficit.

Despite this deficit, post harvest losses were documented by Dada and Gnanados (1983) and Tobor (1984) to account for 50% and 30-50% loss respectively of the total domestic fish production in Nigeria. However, Essuman, (1992) estimated the physical loss of raw fish to be between 20-30%. Till date, despite the improvement in fish processing technology, artisan fishermen have reported large amount of fish spoilage on catch basis.

Ogbondeminu, *et. al;* (1991) stated that modern aquacultural practices are quite new in Nigeria. Therefore, basic information on the bacterial populations and types associated with cultured fish species are not available for the development of preventive measures to safeguard against infectious agents which could cause disease and eventually, financial losses.

Microorganisms such as bacteria, mould and yeast are known to be responsible for putrefaction and the development of poor marketing appearance and toxic substances in fish that may be passed to consumers. However, the role of bacterial flora as a major causative agents of post-harvest losses in fish especially in landing fish have not been given full attention.

The main thrust of this paper is to assess the losses incurred due to the effects of bacterial flora on the quality of fish catch landings or harvested both at the inland water and in fish farm in Nigeria.

BACTERIAL FLORA DYNAMICS

Environmental variation of bacterial flora

Fish, from whichever source either the captured or cultured carry loads of microflora, which vary with geographical area, season, ecological niche, and habitat of the fish (Roberts, 1990). Fish caught in temperate environment carry a lower number of bacterial flora whereas fish caught in tropical environments have slightly higher counts. Very high numbers, i.e., 107cfu/cm2 are found on fish from polluted warm waters (Shewan, 1977). Psychrotrophic Gram negative rod-shaped bacterial belonging to the genera *Pseudomonas, Moraxella, Acinetobacter, Shewanella* and *Flavobacterium* dominate the microflora on temperate water fish. While Gram-positive organisms such as *Bacillus, Micrococcus, Clostridium, Lactobacillus* and *Coryneforms* dominates in the tropical waters Shewan (1977).

However, this conclusion has later been challenged by several studies, which have found that the microflora on tropical fish species is very similar to the flora on temperate species (Lima dos Santos 1978; Acuff, *et al.*, 1984; Surendran *et. al.*, 1989; Gram *et al.*, 1990). Several authors conclude, as Liston (1980), that the Microflora on tropical fish often carry a slightly higher load of Gram-positives and enteric bacteria but otherwise is similar to the flora on temperate water fish.

In polluted waters, high numbers of *Enterobacteriaceae* may be found. In clean temperate waters, these organisms disappear rapidly, but it has been shown that *Escherichia coli* and Salmonella can survive for very long periods in tropical waters and once introduced may almost become indigenous to the environment (Fujioka, *et. al.*, 1988). When water is polluted with sewage then the fish may carry water-borne pathogens such as *Salmonella, Aeromonas hydrophilia, Shigella, Vibrio cholerae* and the hepatitis A virus (Huss, 1988).

Bacterial flora and gear types

The method of harvesting fish could also increase the microbial load in the skin. Trawling with a net on the muddy seabed could increase the number of bacteria on the skin of the fish for as much as 100 times (Eyo, 2001). Fishing with different types of pelagic gear such as mid-water trawl, drift net, floating gill net purse seine or with floating line methods does not have this disadvantage.

Bacterial flora of cultured fish

Bacterial flora was also isolated from the fish skin, gut and the water in outdoor concrete pond in NIFFR, New Bussa (Ogbondeminu, *et. al.*, 1991) as shown in Table I.

TABLE I: Bacterial flora biotypes and percentage of occurrence in fish

Bacterial biotypes	Incidence (%)		
Number of isolate examined	105	76	60
Bacterial biotypes isolated	Water	Skin	Gut
Pseudomonas spp	52	50	24
Aeromonas sp	20	28	28
Citrobacter sp	3	2	0
E. coli	3	3	15
Staphylococcus sp.	3	2	2
Streptococcus faecalis	9	2	15
Micrococcus sp.	0	1	3
Corynebacterium sp.	2	0	0
Klebsiella sp.	3	0	0
Flavobacterium sp.	0	0	1
Unidentified	5	12	12

Source: Ogbondeminu *et. al.* (1991) Modified

Pseudomonas spp. predominated in the bacterial isolates except in fish gut where *Aeromonas sp.* was more dominant. This

also agreed with the work of Nieto, *et al.*, (1984) which revealed the predominance of *Pseudomonas-Aeromonas* species and members of the *Enterobracteriaceae* in the gut of fish.

Fasanya *et.al*; (1988) also isolated some members of the *Enterobacteriaceae*, *Staphylococcus* and *Streptococcus spp*; from gill and skin of cultured *Oreochromis niloticus*. In another study, Ogbondeminu and Okaeme (1989) had also isolated *Pseudomonads, Citrobacter, Klebsiella, Enterobacter, Escherichia, Aeromonads, Acine tobacter, Proteus, Staphylococcus, Streptococcus* and *Salmonella* species from the skin of fish raised in fertilized ponds.

On fish production in the outdoor fish ponds, Okaeme *et al*; (1988) reported infections due to bacterial ulceration, fin, tail and gill rot and dropsy as main diseases occurring in the outdoor fish ponds. The isolates from the lesion included *Pseudomonas sp., Aeromonas sp.,* and *Myxobacteria sp.* This showed that *Pseudomonas sp.* and *Aeromonas sp.* are prevalent in the culture system. And it agreed with the former work of (Austin and Austin, 1987) where the pathogenicity of *Aeromonas species* to fish and their roles in dropsy disease, tail and fin rot has been established.

However, certain fish pathogenic bacteria, *Aeromonas salmonicida, Pasteurella piscicida,* and *Yersinia ruckeri* are considered obligate pathogens as they are generally not found in water free from diseased or healthy carrier fishes. On the other hand, some normal bacterial flora of water such as *Pseudomonas fluorescens, Aeromonas hydrophila, Edwardsiella tarda Vibro sp.,* and *Myxobacteria* can be found on the body surface or in intestinal tracts of fishes and may, under environmental stress, produce epizootic outbreaks. (Ogbondeminu *et. al.*, 1981).

CATEGORIES OF LOSSES CAUSED BY BACTERIAL FLORA

Physical loss

Physical loss can be said to occur when fish is discarded as a result of infection on the fish. For example, fish affected with the tail and fin not disease investigated to be caused by *Aeromonas sp.* can be one of the ways losses were being incurred by the fish farmers as consumers or buyers will definitely reject them. Off-odours implicated to be caused by *Flavobacterium sp.* and *Moraxella sp.* (Table II) is an organoleptic problem of fish quality that could also cause rejection by consumers. The estimated physical loss of raw fish through spoilage according to Essuman (1992) is between 20-30%.

Nutritional losses

Nutritional loss here is the loss in nutritive value of fish due to spoilage brought about by the bacterial flora. A few of the flora invade the fish flesh while microbial growth mainly occur at the surface and nutrient loss may be a consequence of bacterial enzymes diffusing into the flesh and nutrients diffusing to the outside.

Economic losses

The number of bacterial flora on the fish when freshly caught will multiply considerably hence permits spoilage if exposed to a temperature of about 20-25°C for about 3-5 hours between capture and sale as was found in the case of fish caught in Lake Awassa in Ethiopia. (Mogessie *et. al*; 1995). This supports Liston's (1980)

suggestion that the different rates of spoilage were related to different rates of increase in bacteria numbers. This condition is what the fish farmers faces in Nigeria because of the prevalent temperature and the problems of transportation.

TABLE II: Effects of bacterial flora in quality changes, fish health, and likely hazard to consumer

Bacterial flora	Quality change	Health impacts	Hazards to consumer.
Aeromonas sp.	Produce H_2S from cysteine (a)	Tail and fin rot (b)	Diarrhoea, Septicemia (f)
Pseudomonas sp.	Mild off-odour (a)	Fin rot (f)	Wound infection (via skin)
Staphylococcus sp.	-	Septicemia (d)	Localised infection like boil
Streptococcus sp.	-	Streptococcosis, septicemia (c)	Rheumatic fever
Flavobacterium sp.	Off-odour (a)	Gill disease (f)	-
Myxobacterium sp.	-	Lesion (d)	-
Moraxella sp.	Off-odour (a)	-	-
Klebsiella sp.	Form Histamine in fish (e)	Rusty skin (d)	Histamine poisoning (e)
Alteromonas sp.	Produce H_2S from l-cystein and thiosulphate (a)	-	-
Acinectobacter sp.	Proteolytic (a)	-	-

(a) Mogessie *et. al:* (1995) (d) Okaeme and Olufemi, (1998)
(b) Austin and Austin, (1987) (e) Eyo, (2001)
(c) Miyazaki, *et.al.*, (1984) (f) Alecia and Noble, (1996).

Spoilage definitely reduces the fish quality and their market values. Eyo, (1997) noted that spoilt fish were down-graded and sold at a much lower price to be used essentially as fishmeal in livestock feeds. Since freshness of raw fish dictates the market price, poor quality fish are usually sold at give-away prices. Maximum microbial load in fish that determines its freshness has been noted and given as shown in Table III.

TABLE III: Microbial load as related to the fish quality

Fish quality	Microbial load
Fresh fish	$<10^4$ g^{-1}
Sub-fresh fish	$10^4 - 10^5$ g^{-1}
Deteriorated fish	$>10^6$ g^{-1}

Source: Shen, 1995.

The projection of the yearly economic loss in Kainji Lake Area can be estimated looking at the Yield, Cash Value and the projection of the loss in (₦) is calculated using the mean of the percentage range of loss through spoilage (20-30%) estimated by Essuman, (1992). Taking 25% as our mean spoilage loss of the annual yield in Kainji Area, the cash value that would have been lost is shown in Table IV. Despite the deficit in meeting the projected fish demand, fish yield in Kainji area is actually decreasing except the 1996 yield, which was an improvement on the 1995 yield. Even with this decreasing yield spoilage had not stop to take its own toll from the yield. Also to infer from the data is that the average-price of fish has actually increased from about ₦24 in 1995 to about ₦49 in 2001. This makes the cash loss in term of

Naira to increase too. The data above is estimated fish spoilage, which bacterial flora has being causing on fish and the impact on the nation's economy. This assessment serves as a guide to intending fish industry investors most especially as government is planning to privatise her fish farms.

TABLE IV: Fish yield and estimated financial loss in (₦) due to spoilage in Kainji Lake Area

Year	Fish Yield	Cash Value (₦)	Fish Loss (25%)	Loss Value (₦)
1995	32,474	787,411	8,119 (approx.)	196,853 (approx.)
1996	38,246	1,012,030	9,562 (approx.)	256,008 (approx.)
1997	28,753	851,655	7,188 (approx.)	212,916 (approx.)
1998	28,851	914,122	7,213 (approx.)	228,531 (approx.)
1999	16,351	504,840	4,088 (approx.)	126,210 (approx.)
2000	13,375	583,376	3,344 (approx.)	145,844 (approx.)
2001	13,361	654,414	3,340 (approx.)	163,604 (approx.)

Source: Abiodun (2002) modified

RECOMMENDATIONS

- ❖ Quality control and treatment of water (ponds)
- ❖ Enforcement of quality control laws
- ❖ Proper handling of fish
- ❖ Proper gear utilization
- ❖ Processing of manure before been used to fertilize ponds
- ❖ Maintenance of water temperature, pH and salinity
- ❖ Periodic flushing of ponds
- ❖ Isolation of weak and diseased fish
- ❖ Prompt removal of dead fish
- ❖ Transfer of fish by gravitational draining reduces physical stress of fish and
- ❖ Proper boiling of fish before eating

CONCLUSION

In conclusion, the multiplication of bacterial flora on the fish and in the aqueous environment has a serious implication on the health of apparently healthy fish, degree of spoilage in fish and the overall effects on the economy. Also the introduction of some of the organisms into natural water via the faeces in the aquaculture wastewaters may increase the water-borne infection in man.

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